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ABSTRACT

This study was concerned with the validation of the Oklahoma Curriculum and Instructional Materials Center's agricultural mechanics curriculum manual and the development of a model whereby future manuals can be validated. Five units in the manual were randomly selected from a list of units to be taught during the second semester of the 1977-78 school year: servicing small engines, overhauling small engines, electrical safety, fundamentals of electricity, and electrical wiring practices. Ten teachers were selected to teach the units, administer the unit test, and send the tests to the project staff. Results were compiled by determining the percentage of students at each school who obtained the correct answer on each item of the unit test. The school results were combined to obtain the total percentage of students who answered the items correctly. It was arbitrarily determined that 80% of the students should answer each item correctly to demonstrate acceptable achievement. Those items not passed by 80% of the students were reviewed to try to determine the reasons why. Based on student achievement, the manual provided a valid source of instructional materials for servicing small engines. It was concluded that one source could not be identified as the sole reason that learning does or does not take place. (Thirty-one data tables and discussion of analysis on the individual test questions are included.) (JH)

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VALIDATION OF AGRICULTURAL MECHANICS CURRICULUM MANUAL

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NATIONAL INSTITUTE OF EDUCATION

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INTRODUCTION

The Curriculum and Instructional Materials Center (CIMC), Oklahoma State Department of Vocational and Technical Education, has developed a large number of curriculum manuals over the past several years. The format and processes have been standardized and have been adoped by curriculum centers in a number of other states.

Due to the needs of teachers to have immediate availability of good curriculum materials, the CIMC processes have not included a field test of materials before they are released for sale to local schools. The validity of the content is assured through the extensive use of advisory committees composed of vocational teachers and journeymen for the trade or trades to which a specific manual is directed. Field tests have been conducted to assure the manuals are usable by teachers and students, but no field tests have been conducted to assure that students are able to attain the performance objectives delineated in the curriculum.

There is an obvious need to validate the curriculum manuals in terms of student achievement. The purpose of the present study was to validate the Oklahoma CIMC Agricultural Mechanics curriculum manual and to develop a model whereby future manuals can be validated. Five randomly selected units from the manual served as the representative sample.

PROCEDURE

The following activities were accomplished in proceding through the study:

1. Oklahoma teachers who purchased Agricultural Mechanics student manuals for the 1977-78 school year were identified through sales records of the CIMC.
2. A letter was sent to each of the identified teachers requesting that they indicate which units they would teach during the second semester. A copy of the table of contents of the manual was included for their convenience in checking those units they planned to teach. Non-respondents were contacted by telephone to obtain the information.
3. Results were tabulated to identify those units which would be taught by a majority of the teachers during the second semester.
4. A random sample of five units was selected from the eleven units identified in the preceding step. Sixteen teachers were identified who expected to teach all five of the units in the sample.
5. Ten teachers were randomly selected from the sixteen who planned to teach all five units. Criteria for selection were that the teacher agree to teach all five units and to participate in the validation study. In the initial sampling, all sixteen teachers were drawn. Two of the first ten draws could not be located, therefore, the eleventh and twelfth draws were used. The first ten contacted did agree to participate.
6. Project staff set a meeting with the identified sample of teachers during Mid-Winter Conference to fully explain the project and the data collection process. Because of scheduling problems that arose during Mid-Winter Conference, that meeting was not held. Explanations were given by letter and by telephone to each teacher on an individual basis. A small honorarium was

given each teacher for furnishing the data in the format requested.

7. Teachers collected the student achievement data in the following manner. The performance based test which accompanied each unit in the manual was administered by the teacher to each student after the students completed the unit. The tests were graded item by item, i.e. the teacher indicated on each student's test that each item was answered correctly or incorrectly. Teachers were free to include additional test items, to weigh results, or to discount some items in terms of grades given to students, however, the project staff considered only the items on the unit test. As the units were completed, teachers submitted the unit tests to the project staff.
8. Project staff keypunched the item data for each student on each unit and returned the unit tests to the teachers. Item analyses were made on the student data to identify the strengths and weaknesses of the students as a sample.

For some reason not made known to the project staff, three of the teachers who had agreed to participate did not submit any student tests. No attempt was made to see how the loss of data from those three programs might affect the representativeness of the sample. It was assumed that the remaining seven teachers were representative of a variety of the situations in Agriculture Mechanics programs in Oklahoma and the sample of seven could be used to generalize to all programs in Oklahoma. It must be acknowledged that the validation study has been weakened by whatever sampling bias occurred with the loss of the three programs. Results should be conservatively interpreted.

RESULTS

The results from the validation of the Agricultural Mechanics curriculum are presented in Tables 1 through 31. The five randomly selected units were: Servicing Small Engines (Tables 1 through 3), Overhauling Small Engines (Tables 4 through 12), Electrical Safety (Tables 13 through 18), Fundamentals of Electricity (Tables 19 through 24) and Electrical Wiring Practices (Tables 25 through 31). Each table contains the percentage of total students who correctly answered each item of a question. Percentages are broken down by school so a more detailed picture of student achievement may be examined. A brief description of each table is included as an aid in locating the strengths and weaknesses of student performance.

It was determined arbitrarily that 80% of the students should answer the item correctly to demonstrate acceptable achievement of the concept being measured. Items passed by less than 80% of the total number of students should be examined. For example, while Table 1 shows that 98% of the students matched the term "detonation" to the correct definition, Table II shows only 76% of the students were able to identify a screen and sediment bowl fuel filter. The identification of items which do not meet the 80% criteria of achievement may suggest problems in one or several areas.

One of the more basic problems may involve the presentation of the concept in the curriculum. Unclear information or inadequate job sheets may produce confused students and therefore less than adequate understanding of the subject matter presented. This would result in poorer performance on the unit test item measuring this concept.

When only one or two schools have less than 80% of their students passing an item, the problem may be specific to the situation. One cause of a low percentage of students passing a certain question or item may deal with the teacher's presentation of the concept. It is possible that the curriculum materials are adequate but are not being utilized by the teacher in the best way possible. There may be a few units or concepts that certain teachers are unfamiliar with and have difficulty presenting. The result is seen in lowered student achievement.

Another explanation of low achievement may deal with the students themselves. Past experience with the subject, the difficulty of the concepts, innate ability of the students, and motivation to learn influence the performance of a student both positively and negatively. This may account for a situation in which 100% of the students at one school pass an item while only 50% of the students at another school pass the same item.

The environment can act as an influence on student achievement and performance. When dealing with vocational training, the equipment becomes an important aspect of the learning process. If the equipment is not adequate or other environmental influences are not positive, the result may be less than acceptable mastery of the concepts being presented. When the percentage of students passing a test item is less than the 80% criteria it may be due to inadequate facilities rather than the curriculum materials or the teacher.

The possibility that the question itself is not well written should be considered. Although the curriculum has been presented adequately by the teacher and understood by the students, an ambiguous or irrelevant test question could produce spuriously low student achieve-

ment. This problem can be remedied by examining the clarity of those items that are being failed by over 20% of the students. There may also be a need to review the illustrations in the unit tests to assure they are accurate and clear to the students.

The performance items on several units were often not included on the unit test since teachers had already graded students on those items based on the assignment and job sheets. Because our data is incomplete little attempt will be made to infer problems regarding the performance items.

In summary, it is apparent that one source cannot be identified as the sole reason that learning does or does not take place. Many factors, including the curriculum, the teacher, and the environment work together to support the students' learning. The present study can only identify whether students are mastering the concepts as they are measured through the test items. Those items passed by at least 80% of the students indicate that the curriculum, teacher, and other environmental influences have worked together so that a particular task or concept could be learned. Similarly, those items passed by less than 80% of the students indicate there may be a problem with the curriculum, the teaching, the facilities or the question. The present study cannot pinpoint where the problem is located. The table summaries at the end of each unit are only intended as suggestions for attacking a multi-dimensional problem.

TABLE I

SERVICING SMALL ENGINES: QUESTIONS 1 AND 2
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=55	Schools and Number of Students 1 N=8	2 N=6	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.								
a. Butterfly valve	93	88	83	67*	89	100	100	100
b. Choke valve	93	88	83	100	78*	100	100	100
c. Spark gap	95	100	100	33*	89	100	100	100
d. Detonation	98	100	100	100	89	100	100	100
e. Air Cleaner	96	100	100	33*	100	100	100	100
f. Carburetor	96	75*	100	100	100	100	100	100
g. Magneto	95	88	100	67*	89	100	100	100
h. Ignition contact points	89	88	83	0*	89	100	100	100
i. Condenser	95	100	83	67*	89	100	100	100
Question 2. Name four solutions used in cleaning an engine.								
a. (any four of	95	100	100	100	78*	100	100	93
b. eight answers	87	88	100	67*	78*	75*	100	87
c. were acceptable)	89	100	83	67*	78*	100	100	87
d.	82	88	83	33*	78*	100	90	80

Question 1 requires the students to identify the terms covered in the unit. Most of the terms were matched to their correct definition by 95% or more of the total number of students, however, the three students at School 3 did not master this objective satisfactorily. They appeared to be confused on several of the terms--a deficiency that may have negatively influenced their performance on the other test questions.

As a whole, the students mastered the objective tested by Question 2. The two schools that did not meet the 80% criterion may need additional exercises with this material.

TABLE II

SERVICING SMALL ENGINES: QUESTIONS 3 THROUGH 6
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=55	Schools and Number of Students 1 N=8	2 N=6	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 3. Identify the following (illustrated) types of air cleaners.								
a. Oil-bath	93	100	83	100	89	100	100	87
b. Dry-filter	87	100	67*	67*	67*	100	100	93
c. Oiled-filter	82	88	50*	100	56*	100	100	87
Question 4. Identify the following (illustrated) types of fuel filters.								
a. Screen in fuel tank	80	88	67*	67*	67*	75*	100	80
b. Screen and sediment bowl	76*	63*	83	100	56*	75*	100	73*
c. Strainer on pickup hose	82	88	83	33*	67*	100	100	80
Question 5. Identify the following (illustrated) types of carburetors.								
a. Diaphragm	86	100	67*	67*	78*	100	100	80
b. Suction lift	84	100	100	67*	67*	100	100	67*
c. Float	89	100	83	100	67*	100	100	87
Question 6. Identify the following (illustrated) types of magnetos.								
a. Internal	91	100	100	67*	89	100	80	93
b. External	89	100	83	67*	89	100	80	93

Questions 3 through 6 ask the students to examine several illustrations and identify the types of air cleaners, fuel filters, carburetors, and magnetos. Student achievement was satisfactory on most of the items. The percentage of correct answers on Question 4 was the lowest, with 6 of the schools not meeting the 80% criteria on every item. Additional clarification among the types of fuel filters may be an adequate revision to raise student achievement.

TABLE III

SERVICING SMALL ENGINES: QUESTION 7
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=5	Schools and Number of Students 1 N=0	2 N=0	3 N=3	4 N=0	5 N=0	6 N=0	7 N=2
Question 7. Demonstrate the ability to service small engines.								
a. Crankcase & Acc.	100			100				100
b. Cooling System	100			100				100
c. Air-Cleaners								
Oil-Bath	100			100				100
d. Oil-Filtered	100			100				100
e. Dry-Filter	100			100				100
f. Fuel Strainers								
Sediment bowl	100			100				100
g. Screen type	100			100				100
h. Breather	100			100				100
i. Change oil	100			100				100
j. Check plugs	100			100				100
k. Service plugs	100			100				100
l. Service internal magneto	100			100				100
m. Service external magneto	100			100				100
n. Service float-type carburetor	100			100				100

Since only two teachers responded to the performance item it is difficult to arrive at any conclusions. It may be important to note that 100% of the students on which performance was indicated at the two schools were able to satisfactorily complete the many tasks required to service small engines. It is also noteworthy that all three students in School 3 were able to perform the service operations yet did not perform well on the cognitive items.

SERVICING SMALL ENGINES SUMMARY

Most of the objectives outlined for this unit were mastered by over 85% of all the students. Although several schools had problems with some of the items, the low percentages may be an artifact of the small number of students in each class. Since only 3 students were tested in School 3, the percentage drops below the criterion when one student misses the question. On the other hand, since the classes are small, special attention should be easily given to those students who have not mastered the concepts being presented.

TABLE IV

OVERHAULING SMALL ENGINES: QUESTION 1
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=57	1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.								
a. Spark plug	100	100	100	100	100	100	100	100
b. Cylinder block	95	100	91	100	89	100	100	93
c. Piston	86	86	91	67*	100	100	100	64*
d. Conductor	86	71*	91	0*	89	100	90	100
e. Combustion chamber	77*	100	36*	100	67*	100	100	79*
f. Score	93	86	82	100	100	100	100	93
g. Condenser	86	71*	91	33*	78*	100	90	100
h. Intake valve	91	100	91	33*	89	100	100	93
i. Piston ring	97	100	91	100	89	100	100	100
j. Cylinder	84	86	46*	100	89	100	100	93
k. Compression	81	100	73*	100	78*	100	100	57*
l. Exhaust valve	95	100	100	100	100	100	100	79*
m. Combustion	86	86	82	67*	89	100	100	79*
n. Exhaust pipe	95	100	91	67*	89	100	100	100
o. Connecting rod	93	100	82	67*	89	100	100	100
p. Cylinder head	84	100	82	67*	67*	100	80	93
q. Camshaft	88	86	73*	100	89	100	90	93
r. Piston pin	97	100	91	100	89	100	100	100
s. Ignition system	90	100	73*	100	89	100	100	86
t. Carburetor	97	100	91	100	89	100	100	100
u. Crankshaft	86	86	64*	100	89	100	90	93
v. Spark gap	93	100	91	33*	89	100	100	100
w. Governor	95	100	91	67*	89	100	100	100
x. Piston head	95	100	91	100	89	100	90	100
y. Crankcase	93	100	91	100	89	100	90	93
z. Stroke	90	71*	82	33*	100	100	100	100
aa. Gasket	97	100	91	100	89	100	100	100
bb. Spark	88	100	73*	100	100	100	100	71*

Student achievement on matching the terms to the correct definitions was acceptable on all items except one. Although the percentages for the total number of students passing an item are above the criterion, many of the school percentages are not. Restructuring the question may help a few students. A matching question which involves over two pages and 28 items seems cumbersome. Several shorter questions with only 10 options may obtain a better measure of the students' knowledge.

TABLE V

OVERHAULING SMALL ENGINES: QUESTION 2
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=57	Schools and Number of Students 1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 2. List four systems found in a small gasoline engine.								
a. (any four of	91	71*	91	100	78*	100	100	100
b. five answers	90	71*	82	100	89	100	100	93
c. were acceptable)	81	57*	82	100	67*	100	80	93
d.	70*	14*	73*	100	78*	100	60*	86

Question 2 asks the students to list four systems found in a small gasoline engine. Eighty percent of the students were only able to name three systems. While 3 schools mastered the concept satisfactorily, 2 schools had a good deal of difficulty naming one or two systems. It appears the curriculum, the teacher, or the facility is not providing an adequate environment for all students to learn the material.

TABLE VI

OVERHAULING SMALL ENGINES: QUESTIONS 3 AND 4
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=57	Schools and Number of Students 1 N=7	2 N=11	3 N=7	4 N=9	5 N=3	6 N=10	7 N=14
Question 3. Identify parts of the small horizontal shaft gasoline engine on the next page by writing the correct names in the blanks provided.								
a. Fuel tank	98	100	100	100	89	100	100	100
b. Plug wire	95	71*	100	100	89	100	100	100
c. Spark plug	98	100	100	100	89	100	100	100
d. Cylinder head	84	71*	100	100	67*	67*	100	79*
e. Cylinder	88	86	100	100	78*	67*	90	86
f. Valve	90	71*	100	100	89	100	90	86
g. Muffler	86	43*	100	100	67*	100	100	93
h. Valve guide	61*	0*	100	67*	56*	33*	80	57*
i. Carburetor	74*	29*	100	100	56*	100	80	71*
j. Valve spring	81	14*	100	100	89	100	100	71*
k. Push rod or tappet	72*	0*	100	100	56*	67*	90	79*
l. Camshaft	74*	0*	100	100	56*	67*	90	86
m. Crankshaft	83	29*	100	67*	78*	100	90	93
n. Oil fill plug	90	57*	100	100	78*	100	90	100
o. Crankcase	74*	0*	100	100	67*	67*	70*	93
p. Connecting rod	86	71*	100	33*	78*	100	100	86
q. Flywheel shroud	68*	0*	100	100	44*	67*	80	79*
r. Piston	88	57*	100	100	78*	100	100	86
s. Piston pin	84	57*	100	100	67*	100	100	79*
t. Piston rings	88	71*	100	33*	89	100	100	86
u. Engine block	74*	29*	100	67*	78*	100	70*	71*

TABLE VI

OVERHAULING SMALL ENGINES: QUESTIONS 3 AND 4
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY (CONT.)

Item	All N=57	Schools and Number of Students 1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 4. Identify the following special tools needed in overhauling small engines. Write the correct names in the blanks provided.								
a. Flywheel holder	84	27*	100	100	78*	100	100	86
b. Hone	75*	43*	73*	100	67*	67*	100	79*
c. Valve seat cutter	49*	0*	36*	100	44*	33*	50*	79*
d. Valve guide reamer	72*	43*	64*	100	56*	67*	100	79*
e. Ring compressor	77*	29*	91	100	78*	67*	100	71*
f. Ring expander	74*	0*	100	67*	78*	100	80	79*
g. Ridge reamer	60*	0*	55*	100	67*	67*	70*	71*
h. Small hole gauge	49*	0*	27*	67*	33*	67*	90	64*
i. Micrometer	95	86	91	100	89	100	100	100
j. Valve spring compressor	67*	29*	55*	100	56*	67*	100	71*
k. Valve seat refacer	49*	0*	55*	100	22*	33*	50*	79*
l. Starter Clutch wrench	68*	43*	82	67*	67*	33*	80	71*

The poor performance of students at Schools 1 and 4 emphasizes the need to examine the presentation and measurement of the material regarding the small horizonal shaft gasoline engine (Question 3), and the special tools needed in overhauling small engines (Question 4). Both questions require the student to examine an illustration and identify the parts indicated by an arrow. Possibly, the illustrations are not clear enough and the arrows not specific enough for the students to label these parts. The similarity between the illustrations and the equipment may also be lacking. These areas along with the curriculum material should be investigated to try and locate the reason students are not satisfactorily achieving these objectives.

TABLE VII

OVERHAULING SMALL ENGINES: QUESTIONS 5 AND 6
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=57	Schools and Number of Students 1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 5. List five uses for small gasoline engines.								
a. (any five of	98	100	100	100	89	100	100	100
b. seventeen answers	98	100	100	100	89	100	100	100
c. were acceptable)	98	100	100	100	89	100	100	100
d.	95	100	100	100	89	100	90	93
e.	90	100	100	67*	78*	100	90	86
Question 6. Identify the basic operating positions of small gasoline engines by writing the positions in the blanks provided.								
a. Vertical crankshaft	84	43*	82	100	89	100	80	100
b. Multiposition crankshaft	70*	57*	55*	100	67*	67*	90	71*
c. Horizontal crankshaft	74*	43*	73*	67*	89	67*	80	74*

The questions in Table VII deal with uses and positioning of small gasoline engines. Achievement was very high with regard to the five uses of small gasoline engines, but lower with regard to the basic operating positions of these engines. Information sheets do not effectively differentiate among the three types and transparencies inadequately display the types. The transparencies illustrating parts of the engine are incomplete, e.g., the horizontal shaft transparency does not show a condenser, fly wheel, air cleaner, etc.; while the vertical shaft transparency does not show the fuel tank, crankcase, connecting rod, and several other parts. No transparency is included showing parts of a multiposition crankshaft engine.

TABLE VIII

OVERHAULING SMALL ENGINES: QUESTION 7 AND 8
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=57	1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 7. List five items found on an engine nameplate								
a. (and 5 of	95	100	100	100	89	67*	100	93
b. 7 answers	95	100	100	100	89	67*	100	93
c. were acceptable)	88	100	82	100	78*	67*	100	86
d.	84	57*	91	100	67*	67*	100	93
e.	70*	29*	73*	67*	44*	67*	100	86
Question 8. State the importance of being able to read an engine nameplate.	88	86	100	100	44*	100	100	93

Questions 7 and 8 are concerned with an engine nameplate. An adequate percentage of students were able to list 4 items found on the nameplate, but the percentage dropped to 70% on the fifth item. Student performance was good on Question 8, indicating that the importance of being able to read a nameplate has been mastered. Only School 4 had difficulty with the concept.

TABLE IX

OVERHAULING SMALL ENGINES: QUESTIONS 9 AND 10
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=57	1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 9. Describe the differences between two-stroke and four-stroke cycle engines.	56	71*	73*	67*	44*	67*	30*	57*
Question 10. Identify the strokes of a four-stroke cycle engine and two-stroke cycle engine by writing the correct names in the blanks provided.								
a. Four-stroke cycle engine								
1. Power	75*	86	46*	67*	100	67*	70*	86
2. Exhaust	93	100	82	100	89	100	100	93
3. Intake	90	100	64*	100	89	100	100	93
4. Compression	86	100	64*	100	100	100	80	86
b. Two-stroke cycle engine								
1. Intake Compression	74*	29*	91	67*	67*	100	90	71*
2. Power-Exhaust	74*	29*	91	100	57*	100	90	64*

Only 56% of all the students were able to describe the difference between two-stroke and four-stroke cycle engines. The question required the student to list 4 differences in order to receive credit for the item. Restructuring the question with items 'a' through 'd' would allow students to receive credit for those differences that were listed.

An acceptable percentage of students were able to identify the exhaust, intake and compression strokes of the four-stroke cycle engine. The power strokes and the intake-compression and power-exhaust stroke of the two-stroke engine cycle were identified by only 75% of the students. Although students are given exposure to the four-stroke and two-stroke cycle engines in the job sheets, not all of them are learning the terms which accompany the engine parts being manipulated in the classroom experience.

TABLE X

OVERHAULING SMALL ENGINES: QUESTIONS 11, 12, and 13
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=57	1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 11. Identify the parts of a valve by writing the correct names in the blanks provided.								
a. Head	81	57*	73*	100	89	67*	80	93
b. Face	53*	0*	46*	100	56*	67*	20*	93
c. Neck	70*	43*	82	67*	89	67*	30*	93
d. Stem	65*	43*	82	33*	89	67*	20*	86
e. Guide	58*	0*	73*	67*	78*	67*	30*	79*
f. Lock groove	72*	43*	82	100	78*	67*	40*	93
g. Seat	51*	29*	73*	67*	67*	67*	20*	50*
h. Margin	49*	14*	64*	67*	67*	67*	10*	64*
Question 12. Identify the following kinds of rings by writing the correct names in the blanks provided.								
a. Compression rings	84	71*	73*	100	78*	100	100	86
b. Oil scraper rings	81	71*	73*	100	67*	100	90	86
c. Oil control rings	86	71*	91	100	67*	100	100	86
Question 13. Match the kinds of rings to their specific purposes by writing the correct number in the blanks provided.								
a. Oil control rings	91	100	82	100	100	100	80	93
b. Compression rings	95	100	82	100	100	100	100	93
c. Oil scraper rings	93	100	100	67*	89	100	80	100

Performance was poor when the students were asked to identify the parts of a valve. Results show that students at every school did not achieve adequately, an indication that the curriculum may need investigation. Although the parts of a valve are given in an information sheet, and valves are dealt with in the job sheets, the students did not learn the names of the valve parts. There may need to be more emphasis placed on mastering the cognitive skills before attempting the psychomotor activities.

The identification of rings and their corresponding purposes was mastered by well over 80% of the students. Since some students at School 1 and 4 had problems identifying the different kinds of rings, there may be a need for specific assistance by the teachers. Overall, the curriculum seems to be providing an adequate basis for achieving this concept.

TABLE XI

OVERHAULING SMALL ENGINES: QUESTIONS 14 AND 15
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=57	1 N=7	2 N=11	3 N=3	4 N=9	5 N=3	6 N=10	7 N=14
Question 14. Identify the parts of the plain micrometer by writing the correct names in the blanks provided.								
a. Frame	70*	0*	--	100	78*	67*	90	79*
b. Anvil	67*	14*	--	100	67*	67*	80	79*
c. Spindle	54*	14*	--	67*	33*	67*	80	64*
d. Lock	70*	14*	--	67*	67*	100	100	71*
e. Sleeve	61*	0*	--	100	56*	67*	80	71*
f. Thimble	61*	14*	--	100	44*	100	90	57*
g. Ratchet stop	63*	14*	--	100	44*	100	100	57*
Question 15. Read the plain micrometer by writing the readings in the blanks.								
a. 0.053	41*	43*	--	100	33*	33*	90	0*
b. 0.418	35*	57*	--	0*	22*	33*	50*	29*
c. 0.350	63*	86	--	67*	33*	100	90	43*

To correctly answer Questions 14 and 15, the students must be familiar with a plain micrometer. Less than 70% of all the students could identify the parts or read a plain micrometer. Although the curriculum provides instruction for these objectives on an information sheet and an assignment sheet, it apparently is not sufficient for student achievement to reach the 80% criteria. It should be noted that School 6 was able to meet the criteria for all these items (except 15b), a possible indication that something in that environment (teacher or equipment) was able to promote greater student interest and performance. Enriching the curriculum may produce the same effect in the other schools.

TABLE XII

OVERHAULING SMALL ENGINES: QUESTIONS 16 AND 17
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=11	Schools and Numbers of Students 1 N=0	2 N=0	3 N=3	4 N=0	5 N=0	6 N=0	7 N=14
Question 16. Complete engine inspection chart.								
	65*	--	--	100	--	--	--	57*
Question 17. Demonstrate the ability to: (a) Dissassemble, inspect, and reassemble a four-stroke cycle engine, (b) same to a two-stroke cycle engine, (c) Reface valves and valve seats, (d) Replace rings.								
a.	24*	--	--	100	--	--	--	7*
b.	24*	--	--	100	--	--	--	7*
c.	24*	--	--	100	--	--	--	7*
d.	24*	--	--	100	--	--	--	7*

Only two teachers responded to the performance items, as shown in Table XII. Many of the students at School 7 were not able to complete these activities to the satisfaction of the instructor. It appears that the students may not have been ready or had enough guidance to complete the activities. It is not known whether the other schools did not attempt the activities or simply did not indicate so on the test forms.

OVERHAULING SMALL ENGINES SUMMARY

Although the students were able to match the unit terms to their definitions, many were not able to identify the parts corresponding to the terms from looking at illustrations. Student achievement was low regarding the special tools needed for overhauling a small engine, the parts of a horizonal shaft gasoline engine, the parts of a valve, and the identification and reading of a micrometer. It appears that the students are not receiving enough exposure to the names of the engine parts with which they are dealing. Instruction in the information sheet and the transparencies do not seem adequate. There appears to be a need to emphasize the cognitive aspects of the unit as the students work in the psychomotor domain. An incorporation of these two aspects may raise student performance.

TABLE XIII

ELECTRICAL SAFETY: QUESTION 1
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=59	1 N=8	2 N=11	3 N=5	4 N=8	5 N=4	6 N=10	7 N=13
Question 1. Match terms associated with electrical safety to the correct definitions. Place the appropriate numbers in the blanks provided.								
a. Fusetron	92	88	100	80	88	100	100	85
b. Ground fault	95	100	100	100	88	100	100	85
c. Fuse	90	88	82	80	88	75*	100	100
d. Grounded wire	97	100	100	100	88	100	100	92
e. National electrical code	100	100	100	100	100	100	100	100
f. Circuit	100	100	100	100	100	100	100	100
g. Test lamp	100	100	100	100	100	100	100	100
h. Circuit breaker	90	88	91	100	75*	75*	100	92

Student achievement is high with regard to the definition of terms associated with electrical safety. Several items were correctly matched to their definitions by 100% of the students. The curriculum materials and other learning sources have worked together to provide a basis for the students to master the specified objective.

TABLE XIV

ELECTRICAL SAFETY: QUESTIONS 2 AND 3
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=59	1 N=8	2 N=11	3 N=5	4 N=8	5 N=4	6 N=10	7 N=13
Question 2. Name five sources of electrical defects in equipment.								
a. (any 5 of 7	95	100	91	80	88	100	100	100
b. answers were	88	88	73*	60*	88	100	100	100
c. acceptable)	78*	75*	64*	40*	75*	100	90	92
d.	66*	63*	64*	80	50*	75*	70*	69*
e.	58*	63*	55*	60*	13*	75*	70*	69*
Question 3. Name two major causes of electrical accidents.								
a. (any 2 of 5	95	100	91	80	100	100	100	92
b. answers were acceptable)	93	100	100	60*	88	100	100	92

An acceptable percentage of students was not able to name all five sources of electrical defects in equipment. Although 95% of the students could name one source, the percentage dropped to 58 for the fifth source. The students were able to name two major causes of electrical accidents, indicating mastery of that objective is satisfactory. Additional curriculum material dealing specifically with the sources of electrical defects may be helpful in improving student performance on Question 2. The transparency referred to in the Information Sheet shows only one defect. Additional transparencies or a visual display may be helpful.

TABLE XV

ELECTRICAL SAFETY: QUESTIONS 4, 5, AND 6
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=59	1 N=8	2 N=11	3 N=5	4 N=8	5 N=4	6 N=10	7 N=13
Question 4. Discuss ways to free someone receiving electrical shock.								
a. 120-240 volts	85	75*	100	80	88	100	80	77*
b. Over 240 volts	73*	63*	100	40*	63*	100	60*	77*
Question 5. Discuss in a short paragraph first aid for a person who has just received electrical shock.	88	100	82	100	88	100	90	77*
Question 6. Discuss in a short paragraph factors contributing to death from electrical shock.	61*	50*	64*	60*	38*	75*	40*	92

Questions 4 through 6 require the students to discuss different aspects of electrical safety and human lives. The steps necessary to free someone receiving an electrical shock of 120-240 volts and the first aid needed for an electrical accident were two concepts that 85% of the students mastered. Students had difficulty discussing the factors that contribute to death from electrical shock. Only 61% of the students listed the three factors required for credit on the question. Apparently, there was not a sufficient amount of material provided by the curriculum and/or the teachers for the students to be able to master the objective tested by Question 6. Changing the format of the question so that students would get credit for those factors they could list should increase the performance percentages to some degree.

TABLE XVI

ELECTRICAL SAFETY: QUESTION 7
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=59	Schools and Number of Students 1 N=8	2 N=11	3 N=5	4 N=8	5 N=4	6 N=10	7 N=13
Question 7. Identify the following types of circuit protection devices.								
a. Blade fuse	86	100	82	100	63*	100	100	77*
b. Cartridge fuse	64*	88	82	60*	38*	50*	70*	54*
c. Edison base plug	78*	100	91	80	0*	75*	90	92
d. Type S plug	75*	100	81	100	13*	100	80	69*
e. Accessory fuse	83	100	91	80	38*	75*	80	100
f. Single pole circuit breaker	85	100	100	100	63*	100	60*	85
g. Double pole circuit breaker	83	100	91	100	50*	100	60*	92

The total percentage of students with correct answers drops below the criterion on three items mainly due to the low percentage at School 4. Schools 1, 2 and 3 had little problem identifying the types of circuit protection devices, while Schools 5, 6, and 7 performed adequately on some items and poorly on others. A look at the curriculum may give an indication of a need for additional information to assist the students who could not master the material as it is presented. Other special assistance may be necessary for the students in School 4.

TABLE XVII

ELECTRICAL SAFETY: QUESTIONS 8 AND 9
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=59	1 N=8	2 N=11	3 N=5	4 N=8	5 N=4	6 N=10	7 N=13
Question 8. Name five signs that wiring is out-of-date.								
a. (any 5 of 9	88	63*	100	100	63*	100	90	100
b. answers were	92	75*	100	100	88	100	90	92
c. acceptable)	88	88	91	100	63*	100	90	92
d.	78*	75*	73*	80	63*	100	80	85
e.	64*	75*	46*	60*	38*	100	70*	77*
Question 9. Name three reasons for circuit failure.								
a. (any 3 of 4	90	88	91	100	75*	75*	90	100
b. answers were	80	50*	82	80	50*	100	90	00
c. acceptable)	75*	63*	64*	60*	50*	75*	90	100

Looking at Table XVII, it is apparent that the students are mastering part but not all of the information that is necessary for satisfactory performance on these objectives. Performance on Question 8 shows that the students could list three signs that wiring is out-of-date, but not the required five signs. The same phenomenon occurs on Question 9, as 90% of the students could correctly list one reason for circuit failure, but only 75% could list the third reason. Extra time spent with the information may increase the number of correct responses the students make. The nine signs that wiring is out of date could also be signs of other problems. Students might be better motivated to learn these signs if some precautionary procedures are given to follow if a sign is observed.

TABLE XVIII

ELECTRICAL SAFETY: QUESTION 10
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=59	1 N=8	2 N=11	3 N=5	4 N=8	5 N=4	6 N=10	7 N=13
Question 10. Survey home farm for safe and unsafe electrical conditions.								
	100	--	--	--	--	--	--	100

Only one teacher responded to the performance item. The activity was successfully completed by 100% of the students in School 7, however grading the student performance of the survey (in terms of actual unsafe conditions) is highly subjective.

ELECTRICAL SAFETY SUMMARY

Overall performance on the Electrical Safety Unit was favorable. The majority of the objectives were achieved by over 80% of the students. The few items not mastered by a sufficient number of students should be examined further. There is a need to investigate the content of three of the four questions that ask the student to "name" several sources or reasons involved in electrical safety. Most students were able to list two or three responses, but could not correctly list the required five. Extra time spent with these concepts has been suggested as a means to increase the number of correct responses made to these questions.

Another problem area involves the students' ability to discuss the factors contributing to death from electrical shock (Question 6). Since the students in six of the schools had difficulty meeting this objective, a curriculum revision could be helpful to student achievement.

TABLE XIX

FUNDAMENTALS OF ELECTRICITY: QUESTION 1
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=64	Schools and Number of Students 1 N=8	2 N=11	3 N=6	4 N=9	5 N=4	6 N=10	7 N=16
Question 1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.								
a. Ampere (amp)	78*	75*	73*	83	89	50*	60*	94
b. Watt-hour	100	100	100	100	100	100	100	100
c. Kilowatt-hour	98	100	91	100	100	100	100	100
d. Volt	78*	75*	73*	83	89	50*	70*	88
e. Electricity	100	100	100	100	100	100	100	100
f. Watt	89	100	91	83	89	75*	90	88
g. Horsepower	100	100	100	100	100	100	100	100
h. Circuit breaker	94	88	100	67*	89	100	100	100
i. Direct current	98	100	100	100	89	100	100	100
j. Alternating current	98	100	100	100	89	100	100	100
k. Fuse	94	88	100	67*	89	100	100	100
l. Circuit	95	88	100	100	89	100	00	94
m. Switch	97	100	100	83	89	100	100	100
n. Voltage drop	81	75*	73*	67*	89	50*	80	100
o. Resistance	88	75*	82	100	89	75*	80	100
p. U.L.	97	100	91	100	89	100	100	100
q. Short circuit	94	88	100	100	89	50*	100	100
r. Service transformer	83	75*	64*	100	89	25*	100	94
s. Grounding	92	88	91	83	89	75*	100	100
t. Conductors	70*	63*	64*	67*	56*	50*	80	88
u. Single phase	81	75*	64*	100	89	25*	100	88
v. Neutral wires	88	100	73*	100	100	50*	90	88
w. Three phase	94	100	91	83	89	100	90	100
x. Insulation	97	100	100	83	89	100	100	100
y. Meter	98	100	91	100	100	100	100	100
z. Hot wires	81	75*	64*	100	67*	75*	80	100
aa. Kilowatt	98	100	91	100	100	100	100	100

As Table XIX shows, the curriculum has provided the students with sufficient information for them to master the definitions of the terms associated with electricity. A few items were confusing to several students and may warrant some clarification in the curriculum materials. The students at School 5 had the most trouble differentiating among the terms and would probably benefit from extra activities using these terms.

TABLE XX

FUNDAMENTALS OF ELECTRICITY: QUESTION 2, 3, AND 4
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=64	1 N=8	2 N=11	3 N=6	4 N=9	5 N=4	6 N=10	7 N=16
Question 2. Name three benefits of using electricity.								
a. (Any 3 of 6	94	75*	100	83	100	100	90	100
b. answers were	92	75*	100	83	100	100	80	100
c. acceptable)	91	75*	91	83	100	75*	90	100
Question 3. Discuss electron theory.	50*	75*	36*	33*	44*	75*	40*	56*
Question 4. Name the sources of farm electricity.								
a. Indiv. plant	58*	75*	46*	67*	56*	50*	40*	60*
b. Central station	55*	63*	64*	67*	56*	25*	30*	63*

Over 90% of the students were able to name three benefits of using electricity requested in Question 2. The few students that did not attain this objective may need special attention from the teacher.

Student achievement on Questions 3 and 4 is very low. Only 50%-58% of the students could satisfactorily discuss the electron theory or name the sources of farm electricity. The poor performance on these objectives may be due in part to the limited information regarding the concepts in the curriculum. The results on Question 3 may also be a product of the format of the question. Clarifying what information is desired, relating it to flow of electricity and allowing students credit for any correct responses should provide a better measurement of student abilities on the concept of electron theory. On the other hand, understanding the electron theory is not a prerequisite to attaining other objectives in the electricity units, therefore, that objective could be omitted from the manual.

TABLE XXI

FUNDAMENTALS OF ELECTRICITY: QUESTIONS 5, 6, AND 7
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=64	Schools and Number of Students 1 N=8	2 N=11	3 N=6	4 N=9	5 N=4	6 N=10	7 N=16
Question 5. Match the means of transporting electricity to the correct descriptions. Place the appropriate numbers in the blanks provided.								
a. Transmission line	86	100	36*	100	89	75*	100	100
b. Distribution line	83	88	27*	100	89	75*	100	100
c. Service drop line	73*	63*	36*	100	56*	100	70*	100
d. Feeder line	77*	63*	55*	100	50*	100	70*	100
Question 6. Distinguish between 115-volt service and 230-volt service by placing an "X" in the blank representing 230-volt service.								
a. Two lines to house	94	75*	100	67*	100	100	100	100
b. Three lines to house	92	75*	100	67*	100	100	90	100
Question 7. Name the types of power suppliers.								
a. REA coop	84	88	73*	100	67*	100	80	94
b. Public, private	81	88	64*	100	67*	75*	80	94

Student performance on these three questions varied between schools. While all the students at some schools could match the means of transporting electricity to the correct description (Question 5), the percentage of correct answers from those same students dropped to 67 on Question 6. Students at School 2, 4 and 5 had no problems with Question 6 but many of them did not correctly answer Question 5 or 7. This points out the need for teachers to be adequately trained in all aspects of the field they are teaching. There is also a need for the curriculum to be able to overcome any teacher deficiency and provide for as many students as possible the information and materials needed to accomplish the objectives of each unit.

TABLE XXII

FUNDAMENTALS OF ELECTRICITY: QUESTIONS 8, 9, AND 10
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=64	1 N=8	2 N=11	3 N=6	4 N=9	5 N=4	6 N=10	7 N=16
Question 8. Match letter designations used in Ohm's law to the correct terms.								
a. Current-I	93	100	--	100	89	100	80	94
b. Voltage-E	81	88	--	17*	89	100	80	94
c. Resistance-R	87	88	--	17*	100	100	90	100
Question 9. State Ohm's law as related to electricity.	40*	100	--	33*	11*	50*	0*	50*
Question 10. Calculate problems using Ohm's law as related to power.								
a. 208.33 volts	69*	100	55*	67*	33*	75*	40*	100
b. 3.33 amps	64*	100	36*	100	33*	50*	30*	94
c. 480 watts	72*	88	64*	100	44*	75*	40*	94

Questions 8, 9 and 10 deal with Ohm's law. Although a good majority of the students learned the letter designation of the terms, only 40% of the students could state Ohm's law and only 70% could calculate problems using Ohm's law. These results indicate a lack of instruction in the higher cognitive skills involved with this concept. Although the curriculum provides an opportunity for the students to solve problems using Ohm's law, mastery of this objective has not been attained. It is quite possible that neither students nor teachers saw a need to understand Ohm's law as a prerequisite to performing the tasks related to electrical wiring and motor servicing on the farm. Perhaps this objective should also be deleted from the manual.

TABLE XXIII

FUNDAMENTALS OF ELECTRICITY: QUESTIONS 11, AND 12
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=64	1 N=8	2 N=11	3 N=6	4 N=9	5 N=4	6 N=10	7 N=16
Question 11. Name the types of electrical rates.								
a. Residential	75*	100	46*	100	56*	75*	90	75*
b. Commercial	72*	100	36*	83	67*	75*	80	75*
c. Special	66*	100	46*	67*	67*	50*	50*	75*
Question 12. Name the types of kilowatt-hour electric meters.								
a. Pointer-dial	72*	100	46*	83	67*	100	60*	75*
b. Cyclometer	70*	100	36*	100	67*	100	40*	81

Adequate achievement was not obtained for Question 11 and 12. Less than 75% of the students were able to name the types of electrical rates or the types of kilowatt-hour electric meters. The students at School 1 were the only ones who mastered these two objectives completely. The students at School 2 and 4 had the most problems and may be helped with more exposure to the information concept in the curriculum.

TABLE XXIV

FUNDAMENTALS OF ELECTRICITY: QUESTIONS 13 THROUGH 17
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=64	1 N=8	2 N=11	3 N=6	4 N=9	5 N=4	6 N=10	7 N=16
Question 13. Calculate the cost of operating electrical equipment.								
	55*	--	18*	17*	--	--	--	100
Question 14. Solve problems to determine voltage.								
	68*	--	55*	17*	--	--	--	100
Question 15. Solve problems to determine amperage.								
	58*	--	27*	17*	--	--	--	100
Question 16. Solve problems to determine resistances and wattages.								
	68*	--	55*	17*	--	--	--	100
Question 17. Demonstrate the ability to use a:								
a. Voltmeter	75*	--	--	17*	--	--	--	100
b. Ohmmeter	75*	--	--	17*	--	--	--	100
c. Ammeter	75*	--	--	17*	--	--	--	100
d. Watt meter	75*	--	--	17*	--	--	--	100

Questions 13 through 17 require the students to solve problems and demonstrate acquired skills from this unit. The students at three schools completed the problem solving, but less than half the students at Schools 2 and 3 were able to make the calculations correctly. Students at School 3 also had difficulty using a voltmeter, ohmmeter and watt meter. It is not known whether the students at the other schools completed these performance activities.

FUNDAMENTALS OF ELECTRICITY SUMMARY

Student achievement with respect to the fundamentals of electricity varied with the different concepts. Those concepts mastered by 80% of the students included the benefits of using electricity, the distinction between 115-volt and 230-volt service, the types of power suppliers, the letters used to designate the terms in Ohm's law, and the other terms introduced in this unit.

Much of the low achievement revolved around the calculations using volts, amps, watts, and ohms. This objective is dealt with in several assignment sheets. If the students are not completing the assignments, then the poor performance can be explained as lack of related practice. If we assume, however, that the teachers are administering these sheets and the students are working the problems, then there is a need to examine the activities in those sheets to try and determine why they do not provide the students with the skills needed to master the test questions.

The cognitive concepts that were not achieved, (the electron theory, the sources of farm electricity, the means of transporting electricity, the types of electrical rates, and the types of kilowatt-hour electric meters), need to be reviewed. Alternatives for increasing student achievement may focus on the information provided in the curriculum materials or on the teachers and their ability to relate the concepts to the students. Inservice workshops may provide the assistance needed for this unit. A closer examination of cognitive skills needed to perform electrical tasks associated with farm mechanics is in order.

TABLE XXV

ELECTRICAL WIRING PRACTICES: QUESTION 1
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=57	Schools and Number of Students 1 N=6	2 N=10	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 1. Match terms associated with electrical wiring to the correct definitions. Place the appropriate numbers in the blanks provided. Terms and definitions are continued on the following page.								
a. Receptacle outlet	83	100	70*	100	67*	25*	90	100
b. Outlet box	90	100	70*	100	100	75*	80	100
c. Conduit	91	100	90	100	78*	75*	90	100
d. Cord	91	100	80	100	89	75*	90	100
e. Single pole toggle switch	95	100	90	100	89	75*	100	100
f. Cable	91	100	80	100	89	75*	90	100
g. Three-way switch	88	100	80	100	89	25*	100	93
h. Four-way switch	88	100	80	100	78*	50*	100	93
i. Wiring diagram	79*	67*	60*	100	67*	75*	90	93
j. Wire gauge	95	100	90	100	89	100	100	93
k. Schematic diagram	75*	67*	60*	100	56*	75*	90	87
l. Junction box	88	100	90	100	67*	75*	80	100
m. Wire size	95	100	90	100	89	75*	100	100
n. Terminal	84	100	70*	100	78*	25*	90	100
o. Wire	95	100	90	100	89	75*	100	100
p. Conductors	90	100	80	100	89	25*	100	100
q. Polarized	90	100	80	100	78*	50*	100	100

Table XXV shows that most of the terms associated with electrical wiring were matched to the correct definitions by 80% of the students. While the students at a few schools mastered all the terms with little or no difficulty, Schools 4 and 5 showed low student achievement on the items of this question. The students at these schools may profit from supplemental resources supplied by the teacher or the curriculum.

TABLE XXVI

ELECTRICAL WIRING PRACTICES: QUESTION 2
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=57	Schools and Number of Students 1 N=6	2 N=10	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 2. Identify the following tools used in electrical wiring.								
a. Lineman's pliers	79*	67*	50*	100	89	50*	90	93
b. Conduit bender	83	83	70*	100	89	50*	90	87
c. Wire cutter or stripper	88	100	80	100	78*	100	100	80
d. Vise-grip pliers	95	100	80	100	100	100	100	93
e. Keyhole say	88	100	90	100	89	75*	100	73
f. Fish tape and reel	77*	100	30*	100	100	50*	80	87
g. Hacksaw	97	100	100	100	89	100	100	93
h. Test light	90	100	80	100	89	100	100	80
i. Amp-volt meter	77*	100	40*	100	89	50*	90	80
j. Wood chisel	91	100	80	100	89	100	100	87
k. Hammer	98	100	100	100	100	100	100	93
l. Electric drill	91	100	70*	100	89	100	100	93
m. Needle nose pliers	97	100	90	100	89	100	100	100
n. Diagonal pliers	84	100	60*	100	89	75*	100	80
o. Phillips screw-driver	93	100	80	100	89	100	100	93
p. Standard screwdriver	93	100	70*	100	89	100	100	100
q. Tape or rule	95	100	80	100	100	100	100	93
r. Pocket knife	98	100	100	100	100	100	100	93

Question 2 requires the students to examine and identify illustrations of tools used in electrical wiring. Only a few students at two schools were unable to correctly identify the tools, lowering the total performance to 77% on two items. In general the percentages are above 90% and reflect an adequate coverage of the information related to this objective.

TABLE XXVII

ELECTRICAL WIRING PRACTICES: QUESTION 3
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=57	Schools and Number of Students 1 N=6	2 N=10	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 3. Identify the following electrical devices.								
a. Octagon box	79*	83	50*	100	56*	100	100	87
b. Beveled cornered wall box	56*	17*	0*	100	78*	75*	100	53*
c. Edison base plug fuse	79*	100	30*	67*	89	50*	90	100
d. Cartridge fuse	84	100	60*	67*	78*	75*	100	93
e. Connector	75*	100	30*	100	67*	75*	100	80
f. Toggle switch	88	100	60*	100	89	50*	100	100
g. Duplex grounding receptacle	70*	83	20*	100	56*	50*	90	93
h. Surface mount range rec.	70*	100	0*	100	78*	25*	100	87
i. Heavy duty plug	83	83	60*	100	89	75*	90	87
j. Fuse box cover	42*	67*	20*	33*	56*	25*	40*	47*
k. Surface mount d.g.r.	60*	100	20*	33*	67*	50*	50*	80
l. Lock connector and plug	56*	100	10*	33*	67*	50*	70*	60*
m. Crawfoot plug	54*	100	0*	67*	56*	25*	60*	73*
n. Handy box	77*	100	40*	67*	78*	100	90	80
o. Rigid steel conduit	79*	100	40*	100	78*	50*	100	87
p. Flexible steel conduit	84	100	70*	100	78*	75*	100	80
q. 240-volt breaker	83	100	40*	100	89	75*	90	93
r. Ground clamp	67*	100	60*	33*	56*	25*	70*	80
s. Service entrance cap	63*	83	40*	33*	67*	25*	70*	80
t. Weather proof wallplate	61*	100	20*	33*	56*	50*	70*	80
u. Distribution panel	74*	100	30*	67*	56*	75*	100	87

Table XXVII lists the 21 electrical devices that should be correctly identified by the students. Achievement ranged from 42-88% on the various items. The students at most all of the schools were unable to identify the devices, indicating poor performance regardless of the classroom situation. Raising student achievement will probably need to

entail a revision of the curriculum. Although the electrical devices are introduced in the information sheet and job sheets, this has not been sufficient for students to satisfactorily achieve the present objective. In some cases, relating the common name to the proper name, e.g., "Toggle switch (wall switch or light switch);" might assist the student in making the association between a given device and its correct name. Some of the illustrations could be clearer also.

TABLE XXVIII

ELECTRICAL WIRING PRACTICES: QUESTION 4
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	Schools and Number of Students							
	All N=48	1 N=6	2 N=1	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 4. Complete the following chart on conductors, types, and uses.								
a. Wire	60*	100	0*	67*	56*	25*	50*	67*
b. Wire	72*	100	--	67*	44*	75*	50*	93
c. Wire	62*	100	--	67*	33*	50*	40*	80
d. Wire	89	100	--	100	89	100	70*	93
e. Cord	53*	100	--	33*	22*	25*	30*	80
f. Cord	55*	50*	--	67*	49*	25*	40*	80
g. Cord	60*	100	--	67*	33*	50*	30*	80
h. Cord	60*	100	--	33*	33*	50*	40*	80
i. Cord	53*	33*	--	67*	33*	50*	40*	80
j. Cable	89	100	--	100	100	100	70*	87
k. Cable	64*	100	--	100	44*	25*	40*	80
l. Cable	64*	100	--	67*	33*	75*	40*	80

The format for Question 4 is a chart with column headings, "conductors," "types" and "uses." Each item of the question contains two columns with information and one blank column. The student is required to fill in the blank column. In items d. and j., the student was given the "type" and "use" and required to fill in the "conductor" that applied to the given information. These two items were the most successfully achieved. Only 50-65% of the students were able to fill in the "type" when given the "conductor" and "use" or the "use" when given the "conductor" and "type." These results suggest that the material is not adequately dealing with the subject matter and students are not achieving the objective.

TABLE XXIX

ELECTRICAL WIRING PRACTICES: QUESTIONS 5 AND 6
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=47	Schools and Numbers of Students 1 N=6	2 N=0	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 5. Name three factors affecting voltage drop.								
a. (any three of	85	100	--	67*	89	100	90	73*
b. four answers were	81	100	--	33*	78*	100	90	73*
c. accepted)	70*	100	--	33*	58*	50*	80	73*
Question 6. Arrange in order the procedure to follow in wiring. Place a "1" in front of the first step, a "2" in front of the second, and so on.								
a. Use wiring diagram (3)	89	100	--	100	78*	100	90	87
b. Draw schematic diagram (1)	79*	100	--	33*	67*	75*	80	87
c. Draw wiring diagram (2)	85	100	--	33*	78*	75*	90	93

Students performed similarly on Question 5 and 6. The 80% criterion was met on two of the three items of each question. The highest performance occurred at Schools 1 and 6, while the lowest performance was from students at Schools 3 and 4. Apparently, students did not spend enough time with the concept in order to master the objectives. Additional experiences with the information should raise student achievement.

TABLE XXX

ELECTRICAL WIRING PRACTICES: QUESTION 7
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=47	Schools and Number of Students 1 N=6	2 N=0	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 7. Match the electrical schematic symbols on the right to the correct names. Place the correct numbers in the blanks provided.								
a. Contacts, open	83	100	--	100	56*	75*	70*	100
b. Fixed thermostat	81	100	--	100	67*	75*	50*	100
c. Ground connection	81	100	--	100	67*	50*	60*	100
d. Single pole, switch	83	100	--	67*	67*	100	60*	100
e. Single phase motor	79*	100	--	33*	78*	75*	50*	100
f. Thermostat open	68*	100	--	33*	33*	50*	50*	100
g. Transformer	81	100	--	67*	78*	100	40*	100
h. Fuse	92	100	--	100	78*	100	80	100
i. Register, fixed	66*	100	--	33*	33*	50*	60*	87
j. Wire connection	77*	67*	--	33*	78*	50*	80	93
k. Three-way switch	87	100	--	33*	89	100	80	93
l. Wire crossover	75*	67*	--	33*	78*	50*	70*	93
m. Double pole	83	100	--	67*	67*	100	60*	100
n. Four-way switch	85	100	--	67*	100	50*	70*	93
o. Contacts, closed	78*	100	--	33*	56*	75*	78*	93
p. Thermostat, closes	70*	100	--	0*	56*	50*	50*	100
q. Resistor, variable	70*	100	--	33*	44*	50*	50*	100

While the students at Schools 1 and 7 were able to correctly match the electrical schematic symbols to the proper terms, the students at the other schools had a more difficult time with this objective. Looking at the schools individually, very few of the items were matched correctly by 80% of the students. These low percentages indicate a deficit in the learning experience provided by the curriculum, teacher and facility. Since none of the job sheets required the use of schematics, it is suggested that additional job sheets be devised to make use of schematics, that they be incorporated into present job sheets, or that the objective be re-evaluated.

TABLE XXXI

ELECTRICAL WIRING PRACTICES: QUESTIONS 8 AND 9
PERCENT OF STUDENTS WHO ANSWERED CORRECTLY

Item	All N=47	Schools and Number of Students 1 N=6	2 N=0	3 N=3	4 N=9	5 N=4	6 N=10	7 N=15
Question 8. Distinguish between the following drawings by writing schematic or wiring under the appropriate diagrams.								
a. Wiring	83	100	--	100	89	100	50*	86
b. Schematic	83	100	--	100	89	100	50*	86
c. Wiring	80	100	--	33*	89	100	60*	86
d. Schematic	80	100	--	33*	89	100	60*	86
Question 9. Demonstrations.								
Only one response.								

As seen in Question 8, an acceptable percentage of the students were able to distinguish between schematic and wiring diagrams. Only the students at School 6 and two students at School 3 were unclear on this distinction. Additional exposure to these drawings and differentiating between drawings of devices and symbols representing devices should help raise their performance.

Question 9, the performance item, included the four activities specified in the job sheets. A response was received from only one teacher who indicated that one student had successfully completed these activities. It is not known whether the students at the other schools attempted these activities.

ELECTRICAL WIRING PRACTICES SUMMARY

Examining the results of student achievement on this unit, it is apparent that some of the concepts have been adequately achieved while performance on other concepts resulted in poor student achievement. Most students mastered the terms introduced in the unit and the tools used in electrical wiring. The identification of electrical devices and electrical schematic symbols was not achieved by 80% of the students. Achievement was also low on matching the conductors with their types and uses. Generally, the low performance occurred at 5 of the 7 schools, an indication that the problem is not specific to a particular classroom situation. Revising the curriculum manual to include activities that will reinforce the cognitive concepts of the unit is needed. Only a few of the electrical devices and none of the electrical schematic symbols are used in the job sheets. Because of the large number of symbols, tools and parts introduced in this unit, a variety of experiences and repetitive exercises may be necessary to provide a better basis for students to master the specified objectives.

DISCUSSION

The present study was concerned with the validation of the Oklahoma CIMC Agricultural Mechanics manual. Validation was defined by examining student achievement on the unit tests. Satisfactory performance on the unit tests indicated the students were achieving the objectives which in turn indicated that the curriculum was probably a valid source of learning materials. Five units in the curriculum manual were randomly selected from a list of units to be taught during the second semester of the 1977-78 school year. Ten teachers were asked to teach each unit in their usual manner, administer the unit test, score each item as correct or incorrect, and send the tests to the project staff. Each item on the students' test was keypunched and the tests returned to the teacher.

Results were compiled by determining the percentage of students at each school who obtained the correct answer on each item of the unit test. The school results were combined to obtain the total percentage of students who answered an item correctly. A correct answer was considered an indication that the student achieved the objective being tested. It was arbitrarily determined that 80% of the students should pass an item for student achievement to be considered acceptable. Those items that were not passed by 80% of the students were reviewed to try and determine why the students were not achieving the concept involved. Several possibilities of deficient learning sources have been discussed.

The learning source of most concern here revolves around the thoroughness and clarity of the curriculum manual. In some cases, unclear information or an inadequate number of assignment or job sheets may not provide for an acceptable level of student achievement on a particular

concept. Even when the weak source is something other than the curriculum, such as the teacher or the students, supplementing the text may overcome these other deficient sources and work to increase the students' understanding and achievement of the concept in question. Additional sources for improvement may include inservice workshops for teachers and updated facilities and equipment.

The Agricultural Mechanics manual contains information on a wide range of topics, including welding, small engines, tractor systems, electrical power, building materials and soil and water management. The sample of five units used in the present study only involved two main areas; small engines and electrical power. Due to this limitation, no generalizations were made to the manual as a whole. Each unit was considered individually to determine its validity as an instructional tool for student achievement. The units with similar topics were than analyzed together in order to evaluate student performance with regard to a particular section of the manual. Servicing Small Engines and Overhauling Small Gasoline Engines are part of Secion C while Electrical Safety, Fundamentals of Electricity and Electrical Wiring Practices make up most of Section D.

Based on student achievement, the manual provided a valid source of instructional materials for Servicing Small Engines. Students were not as successful on Overhauling Small Gasoline Engines. Low performance on several key concepts (parts of a horizontal shaft engine, parts of a valve and reading a micrometer,) indicates a need to examine the unit as a learning source. Together, these units provided an adequate introduction to small engines. The terms were mastered and most of the service parts were correctly identified. The

more difficult tasks, however, were not achieved, results that tend to question the validity of the material.

An examination of student achievement on the three units that deal with electricity points out several deficiencies in the learning situation. Low performance has occurred on various types of items from identification of tools to discussing the electron theory. As previously discussed, low student achievement is not necessarily a result of invalid curriculum materials. It is felt, however, that improving the curriculum with additional information or clarification of objectives or even reducing the amount of material being presented may work to overcome other deficits and raise student achievement.

An examination of the cognitive skills needed to perform electrical tasks has been suggested. Mastery of concepts such as Ohm's law and electron theory probably have little relevance to the students' ability to use a voltmeter or wire an outlet. Omitting information that is not necessarily required to complete the skills needed for employment in the area should give students more time to learn the essential concepts in the curriculum. An alternative to omitting concepts may be accomplished by incorporating a more direct relationship between the theoretical information and its practical application. Students are more likely to remember information if it can be related to what they deal with in their classroom activities.

Many of the objectives listed in the five units involved the identification of equipment parts, tools or other devices used in agricultural mechanics. These devices were usually presented with transparencies. Much of the equipment involved is very detailed and contains numberous parts situated so that it is difficult to distinguish

between them in a drawing. Because of their complexity it may be necessary for some illustrations to be enlarged, to include illustrations of various positions of the equipment being displayed and/or to clarify the parts being referred to by arrows.

There may also be a need to stress the importance of the performance activities to the teachers. If the teachers are not utilizing all aspects of the curriculum, then it is not the text per se that needs changing, but the presentation of the material to the teachers and their acceptance of the information and the suggestions that are provided. An analysis of the performance items should provide a good indication of whether the teachers are utilizing at least some of the activities. Because many of the teachers did not indicate the students' performance on these items, this analysis cannot be performed for the Agricultural Mechanics curriculum. Further validation studies should include a complete analysis of the students' performance on the assignment and job sheets as they relate to the specified objectives of the unit.

A discussion of the validity of the Agricultural Mechanics manual is most difficult for this research team--none of whom have expertise in the subject area. In our naivete we wondered about the relationship of electricity, structures, and land description to a course in agricultural mechanics. At the same time, we are aware that these topics would be of practical use to those students preparing to return to the farm. For such students, the course is one of "farm and home maintenance." Such topics of study are compatible with the purpose for training in agricultural mechanics skills listed in the orientation unit: "Trains students in basic skills needed on the farm..." It is puzzling, however, to note in the same orientation unit that no electrical or structural occupations are listed under agricultural mechanics occupations.

Perhaps the answer to the problem, (and the rational for the poor achievement made by students), could be found in a better definition of the overall purposes of the course. One explanation is that for students planning to enter production farming, the course offers basic skills in farm maintenance; while it offers exploration in a number of agriculture-related occupations to other students. If such an explanation is accurate, it should be more adequately covered in the orientation unit. Further, the performance objectives in the five skill sections should be re-evaluated. It is unrealistic to think that the students in a class of five hours per week for one year could accomplish objectives at the same level of performance as students in welding, small engine repair, auto mechanics, or electricity who are in class fifteen hours per week for one or two years.

Ultimately, considering the broad content in Agricultural Mechanics, our criterion level of 80% correct answers may be much too high. The curriculum materials may, in fact, be much more adequate than our analyses indicate.